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# Evaluating Game-Based Learning Effectiveness in Higher Education

Mazeyanti Mohd Ariffin\*, Alan Oxley, Suziah Sulaiman

*Department of Computer & Information Sciences**Universiti Teknologi PETRONAS, Bandar Seri Iskandar, 31750 Tronoh, Perak, Malaysia.*

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## Abstract

Game-based learning (GBL) has been widely utilized in various domains such as the military, education, marketing and advertising. Despite its popularity, an assessment of its effectiveness as a learning or a training tool is still unclear. Therefore, the main aim of this research work is to evaluate the effectiveness of using GBL in Higher Education. This paper briefly discusses a proposed research framework, the data analysis framework, some results obtained from a data collection activity, as well as a statistical analysis of the data.

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**Keywords:** Game-based learning(GBL); Learner's background

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## 1. Introduction

The term Game-Based Learning (GBL) retrieved 162 million hits on a Google search and 2.37 million documents, categorized as scholarly papers, on a Google Scholar search. These statistics show that GBL continues to receive substantial interest and attention not only from researchers but also from practitioners that include educators, commerce, the military and health services. With growing concern about the Net generation, GBL is claimed to be an alternative learning and training tool for motivating and training this generation (Prensky, 2003).

Despite the fact that GBL is being widely utilized in a variety of settings and domains, there is still a lack of empirical evidence on its effectiveness in supporting learning and training (Sotomayor & Proctor, 2009;

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\* Corresponding author. Tel.: +605-3687505; fax: +605-3656180.  
E-mail address: [Mazeyanti@petronas.com.my](mailto:Mazeyanti@petronas.com.my)

Hainey, 2010). Furthermore, the available games in the market for use as learning or training tools have been rarely used as examples and metaphors of the player's culture (Robbins, 2006; Mohamed & Mohan, 2011). Osman & Aini (2012) failed to identify available educational game in the market that is suitable to be used in Malaysian context due to our multicultural and multiethnic background. McLoughlin & Oliver (2000) mentioned that the user interface design, teaching strategies approach, and the format and content of educational material are often influenced by the developer's cultural background.

The main focus of this research work is the evaluation of the effectiveness of GBL in Higher Education. However, the scope of this paper is limited to a discussion of the proposed research framework, the methodology, and some analysis and discussion of the data collected during data collection activity. The aim of this paper is to answer two questions. First, whether learner's background has a correlation with learner motivation to learn and learner performances. Second, whether GBL environment has a correlation with learner motivation and learner performance.

To answer the above-mentioned questions, this paper is structured as follows: literature review section discusses the findings from the literature and the proposed research framework, methodology section discusses on the data analysis framework and finally there is the conclusion.

## 2. Literature Review

### 2.1. Computer Game and Game-based learning

A game is *"a physical or mental contest that has specific rules, with the aim to amuse or reward the gamers"* (Zyda, 2005). Hays (2005) provides the following definition of a game or computer game: *"A game is an artificially constructed, competitive activity with a specific goal, a set of rules and constraints that is located in a specific context."*

A game does not represent reality. It is a constructed activity that resembles portions of reality. Games are interactive, which promotes particular behaviours like individual control, trial- and-error and constant change (Birnbaum, 1982). Games provide situated experiences in which players are immersed in complex problem solving tasks (Squire et al., 2005).

Another category of games that captures researchers' interest is the instructional game. Hays (2005) and de Freitas & Oliver (2006) defined instructional games as games that have been specifically designed or modified to meet learning objectives.

Sometimes, researchers call an instructional game as "serious game." The purpose of a serious game is to assist organizations in education or learning. Serious games meet their objectives by including rules, constraints and activities that closely replicate the constraints of the real world tasks that are being trained. Hays (2007) classifies serious games by the type of task to be trained: skills and procedures learning games, action games, role-playing games and strategy games.

Game-Based Learning (GBL) refers use of computer games that possess educational value or different kind of software applications that use games; for learning and education purposes (Tang, Hanneghan & El-Rhalibi, 2009).

Although there is widespread of games utilization in training and learning, there is still a lack of empirical studies that assesses their effectiveness for learning and training. Dorn (1989), Sotomayor & Proctor (2008), and Conrad (2010) highlight that there is insufficient research that look into the effectiveness of games in learning. Most of the claims on the effectiveness are based on the teacher's judgment, and anecdotal and personal encounters. Although many researchers proved that using games increases motivation and interest, however, there is still missing evidence on the effectiveness of games as learning tools. This is supported by, Hainey, Conolly & Boyle

(2009) who suggests that there is a need to create an evaluation framework for evaluating serious games that are used for learning purposes.

Although many researchers try to evaluate game effectiveness, many failed to identify or include control groups that would allow comparison of the results between groups (Hays, 2005). Further, in a paper written by Hainey, Connolly & Boyle (2009) the authors claim that the existing GBL framework is lacking in pedagogy aspects. This is supported by Mazeyanti (2013) who found that there were 16 evaluation frameworks on games which none concentrates on learner background particularly on culture, ethnicity and language spoken by the learners. Knowing the target audience's background is essential before an instructor could consider using a game in class (Bae, 2002; Cho et al., 2011; Sotomayor & Proctor, 2009).

Hong & Liu (2003) and Osman & Bakar (2012) has found that the effect of learner's background and game design influence the overall learner performance. They mentioned that information about the learners' background helps to refine the game design in such that it can provide more effective learning experiences. This includes cultural factors such as the learners' linguistic background, the approach to learning and the communication style that play a pivotal role in learners' readiness and willingness to engage in learning (Pimpa, 2011). Further, the learner background parameters include gender, indigenous status, socio-economic background, language and geographic location (Acara, 2012). These works, has guided this research to focus on learner's background that refers to culture, the language spoken at home, and also ethnicity as explained by Pimpa (2011) and Acara (2012).

## 2.2. *Ethnicity*

A group of researchers at University of Cambridge School of Medicine (2009) describe an ethnic group as a group of people who share the same cultural and/or physical characteristics. An ethnic group shares the same history, political system, beliefs, language, geographical origin, customs, legends, attitudes, cuisines, genetic similarities and physical features.

In Malaysia, ethnicity refers to groups of people that share certain characteristics (Nagaraj et al., 2009). The Chinese Malaysians share a common descent and cultural background. The Indian Malaysians are individuals whose parents share a former citizenship, although the group is culturally diverse. There is a pan-cultural group from different cultural and societal backgrounds broadly considered "similar" (e.g. the Malays). The above groups are the three ethnicities in Malaysia (Dept. of Statistics, 2011). The third group is referred to as the Bumiputera and comprises of Malays, Orang Asli, and native ethnics from Sarawak and Sabah. In this paper, the terms "ethnicity" and "race" are used interchangeably and refer to the same definition.

## 2.3. *Culture*

There is no agreed definition of the term "culture." However, social scientists agree that culture refers to a set of parameters of a collective, where the parameter values differentiate the collectives from each other in a meaningful way. The focus is on the "sharedness" of cultural indicators among members of the collective (House & Javidan, 2002). Culture includes the way a people think and react and these 'skills' are socially transmitted either through direct interaction with, for example, family, friends, the media (Hofstede, 2001). Culture can be divided into two types: (1) individual culture which refers to a set of general knowledge learned by an individual and (2) collective culture which refers to a set of usages, traditions, artistry, beliefs and intellectual expressions that describe and differentiate one group from another group or society (Savard, Bordeau & Paquette, 2008). Mohammed & Mohan, (2011) further mention that the collective culture depends on an individual's ethnic identity, beliefs, observed practices, regional history and geographic location and collective culture is influenced by an individual's culture.

Learners from a certain cultural environment perceive the learning technologies according to their efficacy and cultural influence (Hofstede, 2001). Therefore perceptions, way of interaction, perceived use and usefulness of technology, communication with teachers, view of the course content, and level of computer efficacy are influenced by the environment (Scollon et al., 2004; Mohammed et al., 2011).

## 2.4. Language

According to the Oxford dictionary, “language” is defined as “*the method of human communication, either spoken or written, consisting of the use of words in a structured and conventional way*”. Language can be verbal or non-verbal and is used as a method to communicate or express oneself. Language in this research refers to the language spoken by the learners. The Sapir-Whorf hypothesis states native language strongly affects the way an individual thinks. Hence, language strongly influences the thoughts and perceptions of an individual (Hitosugi & Adviser-Remus, 2009). This is in fact mention by Pimpa (2011), a student’s readiness and willingness to learn is affected by the student’s linguistic background. Pimpa (2011) further claimed that language is one of the potential factors that may hinder the learning process.

## 2.5. Motivation

The term “motivation” refers to “*the general desire or willingness of someone to do something; drive and enthusiasm*” (Oxford English Dictionary). In this research, the motivation is taken to mean the desire to learn.

## 2.6. Learner performance

The term “learner performance” refers to the knowledge acquire by learners as a result of learning or training activity (Sotomayor & Proctor, 2009). In this research, learner performance refers to the increase of knowledge and capability of learner as a result of learning activity.

Figure 1 shows the conceptual research framework underpinning this study. The scope of this research is an evaluation of the effectiveness of integrating the learner’s background parameters into the GBL design.

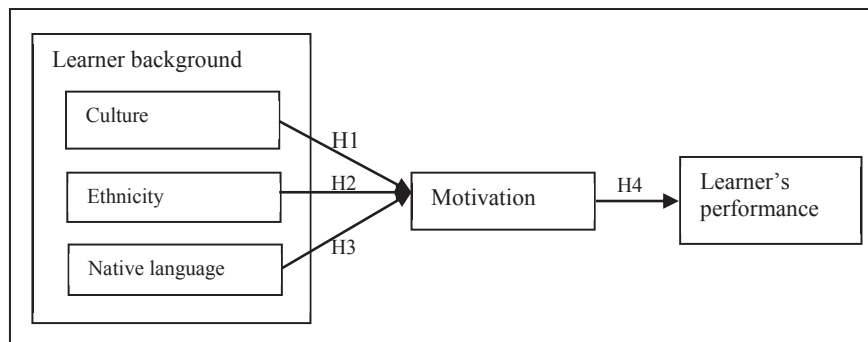


Fig. 1. Conceptual research framework

Following is the list of research questions (RQs) to be addressed in this research work:

- RQ#1: Are students motivated to learn when their cultural elements are portrayed in the GBL environment?
- RQ#2: Are students motivated to learn when the virtual character in the GBL environment represents their ethnicity?
- RQ#3: Are students motivated to learn when the narrative in the GBL environment is in their native language?

## 3. Methodology

### 3.1. Data Collection Method

A questionnaire was distributed to undergraduate students of Universiti Teknologi PETRONAS (UTP) in the January 2013 semester. Participants were recruited from various courses at UTP. The method of collecting data included both hard copy and online submissions. A total of 296 responses were collected of which 167 answered the

online survey while 129 answered the printed forms. From the 296 respondents, eight were eliminated because of incompleteness, hence a total of 288 responses were evaluated. Each respondent received RM5 book voucher for their participation in this study.

### 3.2. Analysis framework

Before running the statistical analysis on the gathered data, the researchers needed to consider the normality of the data distribution. The objective of conducting a data normality test is to determine the appropriate type of statistical analysis to be conducted.

### 3.3. Data normality test

There are two approaches to test data normality: (1) relying on a statistical test and (2) by visual inspection. As for the statistical test, Kolmogorov-Smirnov and Shapiro-Wilk are well known tests of normality. However, Shapiro-Wilk is only suitable for use when the sample size is less than 2000. As for visual inspection, frequency distribution, skewness, kurtosis, and also Normal Q-Q plots can be used. In this research study, the researcher decided to use both approaches because, based on the literatures, relying solely on visual inspection of diagrams may lead to an inaccurate interpretation of the result (Mazlan, 2012).

Table 1. Summary results of normality test

RQ#	Histogram	Skewness		Kurtosis		Shapiro-Wilk	
		Statistic	Std error	Statistic	Std error	Statistic	Sig.
RQ1	Not symmetrical	-0.641	0.144	0.205	0.286	0.817	0.001
RQ2	Not symmetrical	0.475	0.144	-0.411	0.286	0.896	0.001
RQ3	Not symmetrical	-0.445	0.144	-0.593	0.286	0.896	0.001

Table 1 summarizes the descriptive statistics value for each dependent variable that relates to RQ#1 until RQ#3. The result shows that all histograms are not symmetrical and have no bell-shaped graphs. Hence, it indicates that the data for each RQ are not normally distributed.

In addition, the same independent variables were tested for skewness and kurtosis. The value of skewness should be equal to zero for normally distributed data. From Table 1, RQ1 and RQ3 have negative values for skewness which indicates that the data has more low scores hence it is skewed to the left whereas RQ2 has a positive value which shows there are more high scores in the data, hence RQ2 is skewed to right. From these values, it clearly shows that all data related to all RQs is not normally distributed.

Table 1 also shows the kurtosis value for each RQ. The kurtosis value should be equal to zero in order to have a normal data distribution. Only RQ1 has a positive value for kurtosis which indicates it has a peaked distribution that has many scores in the tails and is pointy at both ends. This is called as leptokurtic distribution (Field, 2009). Meanwhile RQ2 and RQ3 have negative values which indicate flat distributions and they have relatively thin tails. This type of distribution is called as platykurtic distribution. From these values, it is clearly shown that all data related to RQs are not normally distributed.

The researchers decided to conduct an additional statistical test in order to confirm the data normality. In this case, the researchers chose to use the Shapiro-Wilk test because the sample size is less than 2000. Table 1 shows the Shapiro-Wilk relevant statistics and the significance values. Statistic value for RQ1 is 0.817 and *p*-value is 0.001, while RQ2 and RQ3 both have value of 0.896 with the significance value is 0.001. Since all *p*-values of all RQs are less than 0.05, hence it is confirmed that the data is not normally distributed.

### 3.3. Hypothesis testing

Based on the result obtained from the data normality test, it is confirmed that the data is not normally distributed hence a Spearman's Rank Correlation (also called Spearman's Correlation) was conducted to test all hypotheses.

Spearman's Correlation was chosen because it is a non-parametric measure of the relationship between two variables. The Spearman's Correlation is identified by the symbol  $r_s$ . The researchers calculated the correlation coefficients by using SPSS v20.

### 3.3.1. Hypothesis #1

$H_1$ : cultural elements portrayed in the GBL environment correlates with learner's motivation to learn

Table 2. Correlation analysis of culture and learner motivation

		Culture	Learner Motivation
Spearman's rho	Culture	Correlation Coefficient	1.000
		Sig. (2-tailed)	.667**
		N	.000
	Learner motivation	Correlation Coefficient	.667**
		Sig. (2-tailed)	.000
		N	.288

\*\* . Correlation is significant at the 0.01 level (2-tailed).

Table 2 shows the correlation analysis of cultural variables and the motivation variable. The  $r$  value is 0.667 which indicates that there is strong correlation between the culture and learner motivation variable. Since the  $p$ -value is less than 0.05 therefore  $H_1$  is substantiated.

### 3.3.2. Hypothesis #2

$H_2$ : ethnicity elements portrayed in the GBL environment correlates with learner's motivation to learn

The correlation analysis of the ethnicity variable and the motivation variable were shown in Table 3. The  $r$  value is 0.842 which indicates that there is a strong correlation between the ethnicity and the learner motivation variable. Since the  $p$ -value is less than 0.05 we reject the null hypothesis ( $H_0$ ) and accept the alternative hypothesis ( $H_A$ ). Hence,  $H_2$  is substantiated.

### 3.3.3. Hypothesis #3

$H_3$ : Native language elements portrayed in the GBL environment correlates with the learner's motivation to learn.

The correlation analysis of the native language variable and the motivation variable were shown in Table 3. The  $r$  value is 0.754 which indicates that there is a strong correlation between the native language and the learner motivation variables. Since the  $p$ -value is less than 0.05 therefore  $H_3$  is substantiated.

### 3.3.4. Hypothesis #4

$H_4$ : learner's motivation to learn correlates with learner's performance

Table 3 shows the correlation analysis of the learner motivation variable and the learner performance variable. The  $r$  value is 0.752 which indicates that there is a strong correlation between the learner motivation and learner performance variables. Since the  $p$ -value is less than 0.05 we reject the null hypothesis ( $H_0$ ) and accept the alternative hypothesis ( $H_A$ ). Hence,  $H_4$  is substantiated.

Table 3. Summary results of hypothesis testing

Elements	Hypothesis	$r_s$	Correlation	p-value	Result
Culture	H1	0.667	strong	( $p < 0.05$ )	H1 substantiated
Ethnicity	H2	0.842	very strong	( $p < 0.05$ )	H2 substantiated
Native Language	H3	0.754	strong	( $p < 0.05$ )	H3 substantiated
Motivation to learn	H4	0.752	strong	( $p < 0.05$ )	H4 substantiated

#### 4. Conclusion

In conclusion, based on the results obtained from the hypotheses testing, it shows that learner's background influenced learner's motivation to learn and thus affected their performance. This result validated the proposed research framework identified earlier in this paper. The next step in this research work is to develop a game which integrates the learner's background parameters into the GBL environment. In this case the parameters are culture, ethnicity and native language.

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